

ANNALS OF SURGERY

VOL. XXXIX

MARCH, 1904

No. 3

ORIGINAL MEMOIRS.

RADICAL OPERATIONS FOR THE CURE OF CAN- CER OF THE PYLORIC END OF THE STOMACH.

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SEVENTY per cent. of all gastric carcinomata involve the pyloric portion and 60 per cent. have their origin at the pylorus or within three inches of it. Considering the fact that radical operation was successfully performed in the time of Billroth (1881), before the inception of modern abdominal surgery, and that during the succeeding twenty-two years more or less work has been done in this field, it is curious that pylorotomy and partial gastrectomy have not as yet achieved an accepted surgical position. There have been a number of reasons for this anomaly; first, a belief that the diagnosis could not be made before the case had advanced beyond the possibility of cure, and, second, that the operation was difficult, prolonged, and bloody, with an almost prohibitive mortality. The first proposition is to a considerable extent true, but not entirely so, as we have in exploratory incision the one diagnostic resource which is reliable, and which must be resorted to in the large majority of cases before a surgical diagnosis can be made.

Without it the truth is but slowly established, at the expense of progressive hopeless involvement. Exploration can be safely accomplished through a small incision and with a short time of disability. It is said that the patient will not submit to an abdominal incision upon suspicion. Herein we do the intelligence of the public an injustice; we have seldom been refused the opportunity, when the matter has been fairly and candidly laid before the patient and his friends. The plea for delay has more often come from the attending physician.

Without going into the question as to the symptoms which would constitute a basis for exploration, the writer would express the opinion that the early diagnosis must be based upon clinical phenomena, the result of observation and experience.

In attempting to solve some of these problems, we have encountered a number of misleading statements which seem to have been generally accepted. Of these three are of sufficient importance to deserve brief discussion: (a) The value of laboratory methods of diagnosis; (b) The significance of palpable tumor; (c) The history of previous ulcer.

(a) Laboratory methods of diagnosis are chiefly based upon chemistry of the gastric secretions (test meals and so forth) and the microscopical examination and chemical reactions of gastric "findings," as well as the urine, feces, and blood. In the surgical stage these examinations have little value, but gain in the diagnostic importance with the progress of the disease to become of the greatest value only when the patient is in hopeless condition. My colleagues, Drs. Graham and Millet, in the examination of somewhat over 1500 stomach and duodenal cases, of which 430 came to operative demonstration, showed this beyond question. These examinations should be made, but exploration should not be delayed by reason of the inconclusive nature of the results.

(b) Tumor. The dictum was advanced many years ago that the presence of a tumor of itself demonstrated inoperability. This is by no means true; a small movable tumor in the pyloric region may be a favorable indication. The early diagnosis of cancer depends in a great measure upon the introduc-

tion of mechanical phenomena from obstruction at the pylorus, with or without palpable tumor; and it is the interference with gastric motility which early calls the attention of the patient to his trouble, and not the presence of the cancer itself. Without these symptoms a surgical diagnosis would seldom be made. In our experience, the patient with marked symptoms of cancer of the stomach, but without any evidence of pyloric obstruction, proves on exploration to be the victim of advanced and hopeless disease of the body, in which there were no symptoms during the operable period.

(c) A history of previous ulcer with complete recovery during a prolonged period of time is apt to be taken as an indication that a present gastric trouble is due to a recurrence of the ulcer and lead the patient and attendant physician to postpone interference. Usually this is true, but too often the renewal of symptoms is due to cancer development upon an ulcer base. We have had this occur a number of times. The author has become a convert to the belief that cancer frequently develops upon an old ulcer scar. Graham, in 145 cases of cancer of the stomach which came to operation at our hands, found a previous history of ulcer in 60 per cent. of the cases, although years may have elapsed after healing of the ulcer before the cancer began. Lebert says that 9 per cent. of ulcers develop cancer, that is, pass directly from the one condition to the other. Ochsner, Futterer, Dunn, and others believe that the irritation of healed ulcer defects in the mucosa furnishes the starting-point for the majority of cancers. Murphy rightly says that precancerous lesions can usually be demonstrated in the history of the case. It is to be noted that the geography of cancer and ulcer is nearly identical.

The second proposition concerns the ulcer itself. There are two local manifestations of the malignant process upon which the advisability of operation depends,—(a) local extent of disease, (b) lymphatic involvement.

(a) Movability of the growth is a very important factor in judging of the extent of disease. Limitation to the pyloric end of the stomach is also of prime importance. Extension to

neighboring organs usually contraindicates operation, with the occasional exception of the transverse mesocolon. The duodenum is rarely involved to any considerable extent. Adhesions are a serious complication not only because they are the advance guard of the cancerous process, but in that they add to the difficulties and dangers of the operation. Haberkant found a death-rate of 73 per cent. operated upon in the face of extensive adhesions and 27 per cent. without such complication. Mikulicz had a mortality of 70 per cent. when there was close adhesion to the pancreas. A moderate amount of adhesions which permit of free motility of the growth has not materially influenced the prognosis in our experience.

(b) Lymphatic infection. This is the most important element in the attempt at cure of cancer of the stomach because the most difficult to estimate of its extent. The mere presence of enlarged lymph nodes does not necessarily imply cancer. Glandular hyperplasia occurs with great frequency in ulcer as the result of infection, and the location of such lymph nodes may lead to the site of ulceration as pointed out by Lund. Ulcerating gastric carcinomata may give rise to infected glands without epithelial invasion, but in practically all cases of gastric cancer the lymphatic structures are involved. In the Breslau clinic, twenty cases out of twenty-one showed glandular involvement. In a general way the lymph channels follow the blood-vessels. On the lesser curvature the blood- and lymph-vessels lie in the wall of the stomach itself, and, as pointed out by Mikulicz, it is necessary in every case of pyloric cancer to remove all of the lesser curvature to the gastric artery. For convenience, this situation on the lesser curvature for the beginning of the line of excision may be called the Mikulicz point of election. We owe a debt of gratitude to Cuneo for his masterly exposition of the lymph drainage of the stomach. He showed that there are but few lymph glands along the greater curvature, and these are confined to the pyloric region. (Fig. 1.) These glands, with the blood-vessels, are set at some distance from the greater curvature, thus enabling rapid expansion and contraction of the stomach, without interference with

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Pneumogastric left

Ganglion

Pneumogastric right

Coronary artery

Coronary vein

Ganglion

Hepatic artery

Gastro-epiploic artery

Ganglion

Gastro-epiploic vein

Adapted

From Hartmann and Cuneo.

BY ALBERT

FIG. 1.—Showing anatomy of the stomach with especial reference to distribution of the lymphatics.

the circulation. The lymph stream in this situation flows from left to right, and does not drain more than one-third of the adjacent stomach, two-thirds going into the lymph channels of the lesser curvature. In the immediate vicinity of the pylorus, however, it drains its fair share. The lymphatics of the greater and lesser curvatures enter the deep receiving glands about the coeliac axis on the anterior surface of the aorta. Cuneo practically demonstrated that the fundus and two-thirds of the greater curvature are free from lymphatic involvement in cancer of the pylorus. Hartmann at once seized upon this basic principle and fixed the point of election for the line of section upon the greater curvature at a healthy place on the gastric wall, to the left of these glands. The distance to the left is regulated by the extent of disease. In a previous communication the author called attention to the lymphatic isolation of the dome of the stomach. This has also been noted by Robson and Moynihan. It is evident that the extent of this free zone along the greater curvature is much wider in pyloric cancer than was at that time considered possible. The retention of this portion of the stomach relieves the operation of many serious difficulties without loss of completeness.

The operation itself can be divided into: (*a*) Incision and exposure; (*b*) Control of hæmorrhage; (*c*) Closing of the stomach and duodenal stumps; (*d*) Re-establishment of the gastro-intestinal canal; (*e*) Avoidance of infection; (*f*) Measures for preventing shock.

The patient's stomach should be cleaned the day before rather than immediately previous to operation, as it may prove to be rather trying to one unaccustomed to the process. A small amount of liquid nourishment may be given after the lavage, but nothing on the morning of the operation. The teeth and mouth should have been previously cleansed as well as possible. A preliminary hypodermatic injection of morphine, to enable the anæsthetic to be reduced to a minimum, may be of value.

(A) A small incision is made in the median line, half-way between the ensiform cartilage and the umbilicus; through this

two fingers are introduced for exploration. If the condition is inoperable, the incision is closed, and a sufficient number of buried non-absorbable mattress sutures of silk, linen, or wire, introduced into the aponeurotic structure of the linea alba to enable the patient to get about at once and to return to his friends within a few days. If sutured in the usual manner, and the patient placed in bed for two or three weeks, many of them will develop hypostatic pulmonary lesions, loss of appetite, swelling of the feet, and general debility, and may be unable to spend their few remaining days at home. When an advanced cancer case goes to bed for a week or two, the chances of his getting about again are small.

Non-absorbable sutures, buried in fixed structures such as fascia and bone, seldom give trouble, and furnish immediate strength. In muscle and movable tissues, atrophy necrosis may occur. We limit their use, however, to the hopeless cases of exploration for malignant disease. If operation is decided upon, the small exploring incision is rapidly enlarged to four or five inches, and a sufficiency of the gastrohepatic omentum is tied off at once close to the liver. This opens the lesser cavity of the peritoneum and mobilizes the pyloric end of the stomach with tumor. The entire area is now packed off with gauze pads.

(B) Control of hæmorrhage. The pyloric end of the stomach is supplied by four blood-vessels,—the gastric and superior pyloric above, and the right and left gastro-epiploics below. By ligating these four vessels early, the operation is rendered practically bloodless. The gastric is doubly tied about one inch below the cardiac orifice at a point where it joins the lesser curvature and divided between the ligatures. The superior pyloric is doubly tied and divided. The fingers are passed beneath the pylorus, raising the gastrocolic omentum from the transverse mesocolon, and in this way safe ligation behind the pylorus of the right gastro-epiploic artery, or in most cases its parent vessel, the gastroduodenal, is secured. (Fig. 2.) The left gastro-epiploic is now tied at an appropriate point, and the necessary amount of gastrocolic omentum

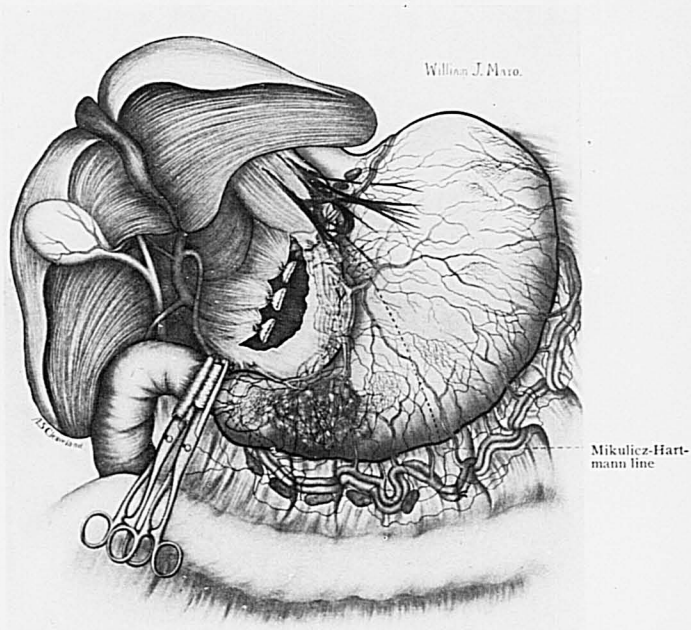


FIG. 2.—Showing ligation of gastrohepatic omentum and superior vessels in such manner as to leave all the lymph nodes attached to the part of the stomach to be excised; also lines of division of duodenum and stomach.

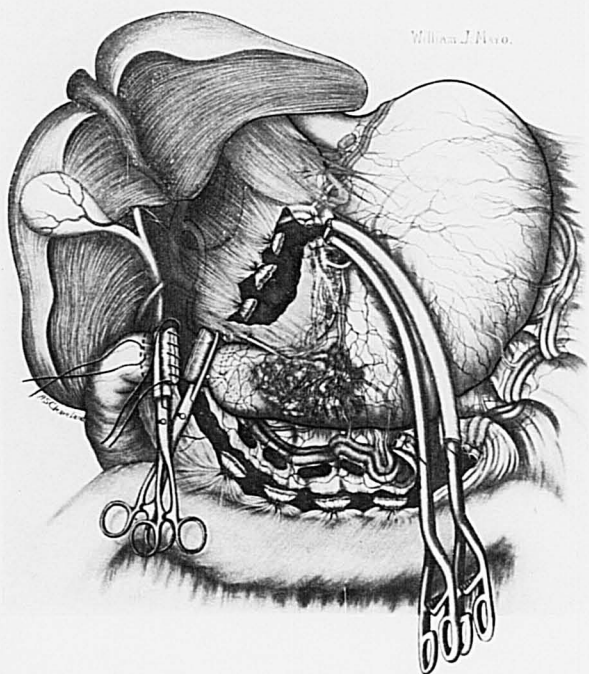


FIG. 3.—Showing methods of excision. Note that all the glands on the greater curvature are removed in every case.

doubly tied and cut. Sometimes the right margin of the omentum becomes very much congested from the venous obstruction produced in this way. In a few cases it has seemed wise to excise the devitalized omentum, especially if drainage is to be used, with its attendant possibilities of secondary infection. In one such case a considerable amount of omental tissue sloughed, although fortunately the patient recovered. If drainage is not used, it will act as an omental graft and give no trouble. It is important that, in ligating the gastroduodenal vessel and the gastrocolic omentum, the fingers should raise the structures away from the middle colic artery which runs immediately beneath in the transverse mesocolon. (Fig. 3.)

The lesser cavity of the peritoneum is a potential rather than an actual space, as the two layers of peritoneum are in contact, and the middle colic has been accidentally caught in tying the vessels from without inward. As this vessel is usually the entire supply of the transverse colon, ligation may result in gangrene of the transverse colon, as pointed out by Kronlein. This has happened a number of times. The control of hæmorrhage is very similar to the ligation of the four vessels concerned in abdominal hysterectomy and fully as easy.

(C) The duodenum is doubly clamped and divided between with the actual cautery to prevent inoculation of the cut surfaces with cancer. (Fig. 2.) The duodenal stump should be left one-fourth inch long, and, before removing the clamp, a running suture of catgut is introduced through the seared stump and tied as the clamp is removed. A purse-string suture of silk or linen, three-quarters of an inch below the stump, enables inversion in a similar manner to the stump of the appendix. (Figs. 2 and 3.) A long Kocher holding clamp is now placed from the tied gastric artery at Mikulicz's point of election in an oblique direction, so as to save as much as possible of the greater curvature to Hartmann's point of election on the greater curvature. (Fig. 3.) The blades of this clamp should be covered with rubber tubing, and the compression should be just sufficient to retain the tissues in its grasp. A second clamp is applied on the tumor side to prevent leakage.

The tissues between are severed with the Paquelin cautery, one-quarter of an inch from the holding clamp, and as the tissues are divided, several catch forceps are caught on the projecting stump to prevent retraction of some part of the gastric wall from the grasp of the Kocher clamp. The pyloric end of the stomach, with the tumor guarded against leakage by the clamp at each end, is removed. The cauterized stump projecting beyond the Kocher clamp is rapidly sutured with a catgut button-hole suture, from the greater to the lesser curvature, through all the coats of the stomach, and in the same manner directly back, and tied at the starting-point; this prevents hæmorrhage as well as leakage. (Fig. 4.) The doubling of this form of suture holds the approximated edges evenly in line. The Kocher clamp is now removed and any bleeding point caught and tied.

The final suture is now introduced of silk or linen, and made after the right-angled plan of Cushing. It is taken sufficiently far from the catgut-suture line to enable easy approximation of the seromuscular layers without tension. (Fig. 5.)

Steps (*b* and *c*) can be varied sometimes to advantage. We have frequently tied off the gastrohepatic ligament and the superior vessels, and at once double clamped and divided the duodenum. By pulling upward on the stomach side the gastroduodenal artery is easily caught, tied, and divided, and the operation proceeded with as before. In a few cases we have begun on the stomach side, ligating and dividing the gastric and left gastro-epiploic vessels first, then clamping, dividing, and suturing the stomach as before. Complete the duodenal end with its vessels last. This is favored by Hartmann. If there are adhesions, however, the first plan mobilizes the stomach much better, and enables more accurate work and greater exposure of that part of the stomach which at the line of section lies naturally deep under the costal arch.

(D) Restoration of the gastro-intestinal canal was first accomplished by Billroth, by joining directly the cut surface of the duodenum to the shortened stomach, the opening of the latter viscus being partly sutured to reduce it to the size of the

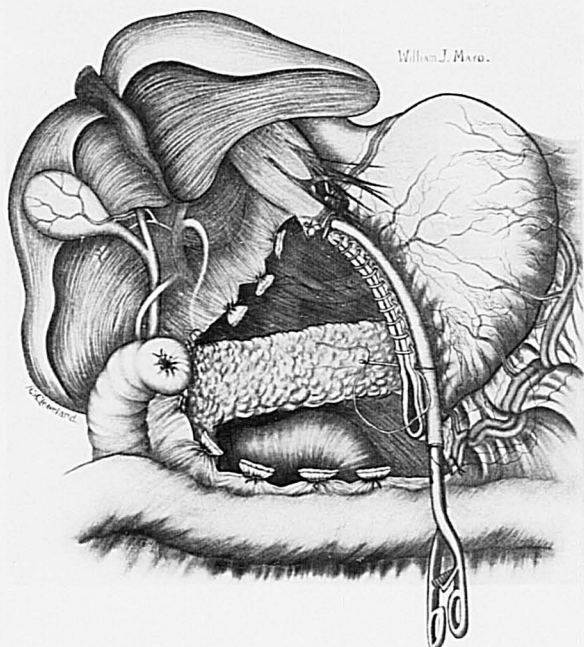


FIG. 4.—Showing closure of cut duodenal end by circular suture and first row of sutures being placed on the stomach side.

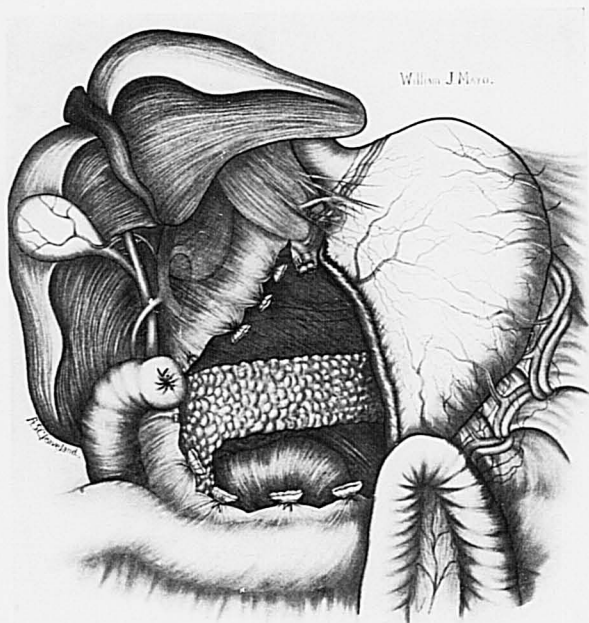


FIG. 5.—Showing completed operation

duodenal end. The angle where the three suture lines came together leaked so often, especially if there was the least tension, that it was called the "fatal suture angle." Kocher saw the defect in this method, and began implanting the cut end of the duodenum to the posterior gastric wall at a sound point, and completely closed the stomach. This method gives excellent results, if there be no tension, in bringing the parts into easy apposition. Unfortunately, this often happens.

Billroth's second operation is the operation of choice, complete closure of the duodenal and stomach ends with an independent gastrojejunostomy of the usual type. It has the two chief requisites of gastro-intestinal anastomosis; there is no tension, and the parts to be united have not been injured. Either the anterior or posterior method can be used and the Murphy button or suture operation be performed. If the patient is in good condition and the operation has been completed promptly, we prefer the posterior suture method; if the patient's condition is poor, the anterior button operation is chosen. (Fig. 5.)

(E) Infections. The question of cancer infection grafted upon a raw surface is an important one. We have seen carcinomatous nodes develop in the abdominal incision and in the abdominal needle punctures made in suturing the abdominal wall after partial gastrectomy. Dissemination of carcinoma by rough handling or allowing infected cells to escape into the wound is not uncommon. It is for this reason that all sections of the diseased part are made with the actual cautery, which prevents inoculation of raw surfaces and checks capillary hæmorrhage, and leaves the approximated ends in an aseptic condition until they are digested back to the outer suture line. Pyogenic infection is prevented by the clamps placed upon each side of the excised stomach, sealing against escape of contents, while the exposed edges beyond the clamp are sterilized by the use of the cautery in making the section. In addition to this the gauze pads are arranged in two rows,—an outer deep layer, which is not changed until final removal, and an inner superficial layer, which is being constantly renewed. Upon

removal of the final gauze pack the entire field is carefully gone over and any little bleeding point checked by ligature. After sponging the surfaces with a moist saline gauze pad, the abdominal incision is closed. In some cases drainage seems wise on account of accidental soiling. This is seldom necessary, but if in doubt, drain, and best with a cigarette drain placed at the lower angle of the external wound, entirely away from the visceral suture lines. The internal end of the drain should reach to a situation just above the transverse colon, which acts as a dam when the patient is placed in the proper position in bed,—head and shoulders elevated. In this half-sitting posture, the little pouch formed by the transverse colon is not unlike an artificial pelvis into which any fluids gravitate. If there be but a limited area to be quarantined, the gauze should be brought out in the most direct manner possible.

(F) Shock. If the patient is in good condition, there is practically no shock, because there is no blood loss and little exposure of abdominal contents. The operation proceeds systematically, and can be done in a suitable case by the average operator, from the beginning of the abdominal incision until it is closed, in from fifty minutes to one hour and fifteen minutes. If the patient's condition is very poor, owing to early obstruction, the chief danger comes from the lack of fluids in the body. As suggested to us by Dudley Allen, this should be made up by subcutaneous infusions of saline solution, forty to sixty ounces a day, usually twenty to thirty ounces every twelve hours, for two days previous to the operation. This is continued for several days following operation, if necessary. In these dehydrated patients, it is almost impossible to get sufficient fluids into them in any other manner. For subcutaneous infusions, we prefer the ordinary Davidson syringe, to which is attached an aspirating needle. The hand-bulb enables nice regulation of the inflow. The whole can be boiled, and the infusion given by a nurse as easily as an enema. In debilitated patients very little anæsthetic is used, just enough to enable the surgeon to open and close the abdomen. All of the

visceral work can be done without pain. The previous exhibition of morphine keeps the patient from becoming nervous.

An enema of six ounces of coffee is given as soon as the patient is put to bed. If necessary, morphine, strychnine, or like remedies are exhibited.

The after-treatment is simple,—the head and shoulders of the patient are raised by four or five pillows, rectal alimentation is instituted, hot water by mouth after twelve hours in tablespoonful doses, increased to an ounce every hour. After thirty-six hours the usual experimentation with liquid foods is begun.

To recapitulate, there are six important stages to the operation as outlined.

Step 1. Open the abdomen. Step 2. Double ligate and divide the gastric artery; ligate and divide the necessary amount of gastrohepatic omentum close to the liver, leaving most of its structure attached to the stomach. Double ligate and divide the superior pyloric artery and free the upper inch or more of the duodenum. (Fig. 2.) Step 3. With the fingers as a guide underneath the pylorus, in the lesser cavity of the peritoneum, ligate the right gastro-epiploic or gastroduodenal artery, and progressively tie and cut away the gastocolic omentum distal to the glands and vessels up to the appropriate point on the greater curvature, and here ligate the left gastro-epiploic vessels. (Fig. 3.) Step 4. Double clamp the duodenum, divide between with the cautery, leaving one-fourth inch projection. With a running suture of catgut through the seared stump the end of the duodenum is closed as the clamp is removed. A purse-string suture about the duodenum enables the stump to be inverted. (Figs. 2 and 3.) The proximal end of the stomach is double clamped along the Mikulicz-Hartmann line (Fig. 3) and divided with the cautery, leaving one-fourth inch projection. Suture through the seared stump with a catgut button-hole suture. This is again turned in after removal of the clamp by a continuous silk or Cushing suture. (Figs. 4 and 5.) Step 5. Independent gastrojejunostomy. (Fig. 5.) Step 6. Closure of the wound.

There have occurred in the hands of my brother, Dr. Charles H. Mayo, and myself forty-one radical operations upon the pyloric end of the stomach, thirty-seven for cancer, four for inveterate ulcer. Of these, thirteen have been made essentially by the plan outlined above, with one death. There were six deaths in the remaining twenty-eight cases, performed by various methods. In the last eleven cases this technique was used practically as given, and there were no deaths. Making all due allowance for increased experience and possibly better selection of cases, the difference is too marked to be entirely accidental. It is hardly necessary to say that this is a composite operation, and in no sense to be considered original.

In a previous contribution on this subject, published in the *ANNALS OF SURGERY* for July, 1903, a somewhat similar operation was recommended by the writer, only that it was far more extensive, removing all of the stomach excepting the dome. With increased observation and experience, the author feels the former operation, with a mortality of three deaths in eight cases, to be unnecessarily severe for the average case of pyloric cancer. The operation described at that time has a place in surgery, and should be used in the cases of more extensive disease involving the body of the stomach. In these cases it has practically all the advantages of complete removal of the stomach, and should be used as a substitute for total gastrectomy where possible. The operation herein described with a mortality of one in thirteen should be the operation of choice for the average case of fairly early disease of the pyloric region.